CHEMISTRY

www.chem.waikato.ac.nz

Chemistry is the science of substances–their structures, their properties and reactions that change them into other substances. Knowledge of basic chemical principles is important in all branches of science and for a wide range of industries. Better building materials and textiles, improved medical aids, new alloys, more productive agriculture, better environmental control – all rely on chemical expertise. The basic understanding of how substances are interrelated and transformed provides the framework upon which the other observational sciences are built. In addition to being an important area of science in its own right, chemistry also forms an integral part of the study of the biological sciences and earth sciences. The Department of Chemistry covers a wide range of specialist areas including the interface between chemistry and the other sciences, such as analytical chemistry, geochemistry, environmental chemistry, forensic science, industrial chemistry, materials chemistry and biochemistry. Chemistry forms a major growth area in modern science for both research and employment.

Waikato was rated the top university in New Zealand for chemistry in the Tertiary Education Commission's 2006 assessment of tertiary research.

CONTACTS FOR THE DEPARTMENT OF CHEMISTRY

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Degrees

Chemistry is available as a major subject for the Bachelor of Science or Bachelor of Science (Technology) degrees. The Department of Chemistry offers papers, programmes and degrees that cover the full breadth of chemistry, and at all levels of study from pre-degree and undergraduate degrees through to postgraduate and doctoral studies.

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Chemistry Major

General Structure of a Chemistry Major for the BSc and BSc(Tech) degrees

100 LEVEL	**CHEM101** 15 points	**CHEM102** 15 points	
200 LEVEL	**CHEM201** 20 points	**CHEM202** 20 points	**CHEM203** 20 points
300 LEVEL	**CHEM3XX** 20 points	**CHEM3XX** 20 points	**CHEM3XX** 20 points

100 Level – Prerequisites: CHEM101 Chemical Concepts and CHEM102 Chemical Change and Organic Compounds.

200 Level – CHEM201 Organic Chemistry, CHEM202 Physical Chemistry and CHEM203 Inorganic Chemistry.

300 Level – Choose from: CHEM301 Advanced Organic Chemistry, CHEM302 Advanced Physical Chemistry, CHEM303 Advanced Inorganic Chemistry and CHEM306 Advanced Analytical Chemistry.

Specialisations

Students may undertake the following specialisations for the BSc and BSc(Tech) major in Chemistry.

» Agribusiness	*
» Science International	page 157
» Te Pūtaiao me ngā take Māori	page 162

**Enrolment in this specialisation should be completed in consultation with both the Faculty of Science & Engineering and the Waikato Management School.*

Choosing Papers

Entry into Chemistry Papers

The normal entry level to 100 Level Chemistry papers is 14 credits at NCEA Level 3 or higher in chemistry. Students may also be admitted at the discretion of the chair of the department, on a case by case basis. Alternatively, there are programmes available to assist you to the appropriate level. These may either be the Certificate of University Preparation (page 21) or, if you have some Chemistry background, Science Foundation (page 19). If you are considering either of these options, we strongly recommend that you seek advice from staff in the Dean's Office of the Faculty of Science & Engineering.

Chemistry Major

To complete a major in Chemistry, students must complete 120 points above 100 Level, including 60 points above 200 Level from compulsory chemistry papers.

100 Level – Papers are worth 15 points.

Students wishing to keep their options open to progress in chemistry or a related field should choose the two core papers:

Prerequisites

- CHEM101A – Chemical Concepts
- CHEM102B – Chemical Change and Organic Compounds.

Students with good passes in NCEA Level 3 chemistry may also be offered direct entry to the paper CHEM204 Analytical Chemistry and Instrumental Techniques in place of CHEM101.

200 Level – Papers are worth 20 points unless specified.

Compulsory Papers

- CHEM201B – Organic Chemistry
- CHEM202A – Physical Chemistry
- CHEM203B – Inorganic Chemistry

If possible, it is best to take all these papers in the one year, as mixing them with 300 Level papers may lead to timetabling problems. Students intending to take CHEM306 Advanced Analytical Chemistry at 300 Level should also ensure they take its prerequisite paper CHEM204 Analytical Chemistry and Instrumental Techniques.

300 Level – Papers are worth 20 points unless specified.

Students must pass at least three of the following papers:

- CHEM301A – Advanced Organic Chemistry
- CHEM302B – Advanced Physical Chemistry
- CHEM303A – Advanced Inorganic Chemistry
- CHEM306B – Advanced Analytical Chemistry

The other papers needed to complete the degree requirements of the BSc and BSc(Tech) may come from further optional papers in chemistry, other science subjects or subjects from other faculties/schools of studies.

Students not intending to major in Chemistry

If you are not a Chemistry major, please feel free to sample from our wide variety of paper offerings. Generally, it will be easiest for you to pick up chemistry papers at 100 and 200 Levels, as these papers will be less affected by prerequisite requirements. The papers CHEM204 Analytical Chemistry and Instrumental Techniques, CHEM209 Chemistry: Human Perspectives, CHEM261 Geochemistry and Environmental Chemistry, and CHEM305 Environmental, Forensic, Toxicological and Medicinal Chemistry are particularly recommended.

Timetable Clashes

Your selection of papers may depend on your timetable. You will not usually be permitted to take papers which have lecture clashes. Laboratory clashes can usually be resolved. You should contact the Department if you have a laboratory clash.

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Chemistry Papers

100 Level Papers

CHEM101-12A (HAM) & 12A (SEC) – Chemical Concepts
15 Points
This paper revises ideas of balanced equations and the mole concept in quantitative calculations and treats chemical equilibria in detail, with particular emphasis on acids and bases, and aqueous solutions. The detailed structure of the atom is explored, with qualitative derivation of quantum numbers to describe electron energy levels (orbitals). Atomic properties are rationalised and the Periodic Table is used as a basis for a systematic survey of descriptive inorganic chemistry. Examples are chosen to illustrate aspects of chemistry of practical importance.

One laboratory session of three hours per week provides training in practical skills.

This paper is a basis for continuing to higher-level chemistry papers, as well as providing core chemical ideas for students who intend studying in other science subjects.

Co-ordinator(s): *Professor Brian Nicholson*
Lecturer(s): *Professor Brian Nicholson and Professor Bill Henderson*
Prerequisite(s): *14 credits at Level 3 NCEA Chemistry or equivalent*
Required book(s): *Brown et al **Chemistry in the Central Science** (Prentice Hall)*
Assessment: *Internal assessment/examination ratio: 1 : 2*

CHEM102-12B (HAM) & 12B (SEC) – Chemical Change and Organic Compounds
15 Points
This paper introduces two of the core themes of chemistry, namely organic chemistry and physical chemistry. In organic chemistry, the common functional groups are introduced, along with their typical reactions, especially those involved in bioorganic chemistry. This paper provides most students with their first introduction to physical chemistry, with the concepts of chemical thermodynamics (the energy effects and the equilibrium position of chemical reactions), chemical kinetics (the rates of chemical reactions) and reaction mechanisms (how these reactions take place). One laboratory session of three hours per week enables students to investigate these principles for themselves and provides basic skills of practical chemistry.

Co-ordinator(s): *Associate Professor Merilyn Manley-Harris*
Lecturer(s): *Dr Michael Mucalo*
Prerequisite(s): *14 credits at Level 3 NCEA Chemistry or equivalent*
Recommended book(s): *Brown et al **Chemistry in the Central Science** (Prentice Hall)*
Assessment: *Internal assessment/examination ratio: 1 : 2*

CHEM106 – Chemical Hazards: Safety and Legislations
15 Points
This paper will not be offered in 2012.

ENVS101-12B (HAM) – Environmental Science
15 Points
For details refer to Environmental Sciences ENVS101.

200 Level Papers

CHEM201-12B (HAM) – Organic Chemistry

20 Points

A study of organic stereochemistry, mechanism and reaction intermediates, including their relevance to biological and industrial chemistry. This paper provides an introduction to aromatic chemistry, carbohydrate chemistry and NMR spectrometry.

Lecturer(s):	*Associate Professor Merilyn Manley-Harris and Dr Michèle Prinsep*
Prerequisite(s):	*CHEM102*
Restriction(s):	*CHEM221 and CHEM231*
Required book(s):	*McMurray **Organic Chemistry** 6th or 7th ed (Brooks/Cole); Molecular model set (available from the Chemistry Department)*
Assessment:	*Internal assessment/examination ratio: 1 : 1*

CHEM202-12A (HAM) – Physical Chemistry

20 Points

A study of chemical thermodynamics including heat engines, entropy, life processes, and environmental consequences of technology; phase equilibria, eutectics, conductance of electrolytes, chemical kinetics, Nernstian electrochemical cells, batteries and fuel cells.

Lecturer(s):	*Dr Michael Mucalo and Dr Joseph Lane*
Prerequisite(s):	*CHEM102*
Restriction(s):	*CHEM221 and CHEM231*
Required book(s):	*Engel and Reid **Physical Chemistry** (Pearson)*
Assessment:	*Internal assessment/examination ratio: 1 : 1*

CHEM203-12B (HAM) – Inorganic Chemistry

20 Points

Inorganic Chemistry covers the chemistry of all elements in the Periodic Table. This paper provides the foundations of inorganic chemistry, which are then further developed in the 300 Level Inorganic Chemistry paper CHEM303. It also covers knowledge relevant to fields such as materials science, geochemistry and biochemistry.

A detailed analysis of covalent bonding in small molecules leads on to an examination of the shapes and properties of small molecules formed by the s- and p-block elements. Physical methods of structure determination are also covered. Solid-state chemistry, relevant to the study of metals, minerals and other solid materials, is discussed in terms of structural types and bonding. The principles of bioinorganic chemistry are also introduced in this paper.

The remainder of the paper covers the detailed chemistry of the transition metals including different theories available for explaining the magnetic, thermodynamic, physical and structural properties of co-ordination compounds. The descriptive chemistry of the transition metals is supplemented by an independent study in the form of a short essay.

The practical work, in the form of twelve three-hour sessions over a six-week period, concerns the chemistry of both main-group and transition elements. Experiments are designed to give the student experience in the synthesis of inorganic compounds, together with their characterisation by techniques such as NMR, UV-visible and infrared spectroscopies, magnetic measurements, and electrospray mass spectrometry. The manipulation of compounds using vacuum line techniques is also covered.

Lecturer(s):	*Professor Bill Henderson and Dr Graham Saunders*
Prerequisite(s):	*CHEM101 or CHEM204*
Required book(s):	*Henderson et al **Introduction to Modern Inorganic Chemistry** 5th or 6th ed (Nelson Thornes)*
Assessment:	*Internal assessment/examination ratio: 1 : 1*

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CHEM204-12A (HAM) – Analytical Chemistry and Instrumental Techniques
20 Points
Many disciplines, including agriculture, archaeology, biology, chemistry, engineering, environmental science, forensic science, geology, and medicine, rely heavily on analytical chemistry in solving routine problems and in research. This being the case, a sound understanding of the principles and techniques in analytical chemistry is one of the most sought-after skills in research and the modern workplace.

The intent of this paper is to give students introductory theoretical and practical exposure to a broad range of principles and techniques used in chemical analysis, and to provide a foundation for more advanced studies in the discipline (CHEM305 and CHEM306).

The laboratory component of this paper involves 36 hours of work on such topics as qualitative inorganic analysis, gravimetric and volumetric methods, chromatographic techniques (thin layer and gas-liquid), and spectroscopic techniques (atomic absorption, atomic emission, infra-red, UV-visible, and X-ray diffraction).

Laboratories are run as two three-hour sessions per week for six weeks for students majoring in Chemistry, and one three-hour session per week for twelve weeks for students with other majors and direct-entry students.

Lecture content is designed in such a way as to support the laboratory paper, with discussion of the theory underlying a range of techniques in instrumental and wet-chemical analysis. CHEM204 is entirely internally assessed, with 50% of the mark being based on tests on the lecture material, and the other 50% being based on the experiments carried out in the laboratory work.

This paper is highly recommended for those students planning a major in Chemistry, students including chemistry as part of the BSc (Technology) programme, and students taking environmental science, geochemistry, or biochemistry. The majority of New Zealand chemistry graduates secure jobs in which analytical chemistry forms a significant part. This is also an excellent service course to take for students majoring in Biological Sciences, Earth Sciences, and Materials & Processing.

Students with a strong background in Chemistry may be offered the option of taking CHEM204 in place of CHEM101.

Lecturer(s):	*Dr Michael Mucalo, Associate Professor Merilyn Manley-Harris, Professor Brian Nicholson, Associate Professor Alan Langdon and Dr Graham Saunders*
Prerequisite(s):	*CHEM101 or CHEM102*
Required book(s):	*Kellner et al **Analytical Chemistry** (Wiley)*
Assessment:	*Internal assessment/examination ratio: 1 : 0*

CHEM209-12B (HAM) – Chemistry: Human Perspectives
20 Points
A paper on the molecular basis of aspects of human health and wellbeing chosen from the areas of inorganic and organic drugs, drug design and delivery; foods and diet; natural products of human utility, aging, cosmetics and toxicology, and other topics.

Lecturer(s):	*Professor Bill Henderson, Dr Michèle Prinsep, Professor Alistair Wilkins Dr Michael Mucalo and Dr Graham Saunders*
Prerequisite(s):	*CHEM102*
Assessment:	*Internal assessment/examination ratio: 1 : 1*

CHEM261-12B (HAM) – Geochemistry and Environmental Chemistry
20 Points
This paper is designed to give students in chemistry, earth sciences and biological sciences an understanding of the chemistry of our environment. The composition of the earth, particularly its atmosphere and hydrosphere, and its derivation from the solar system, will be examined. Concepts of residence times, fluxes and geochemical cycles will be introduced. The features that make the Earth unique among the known planets, and habitable, especially the importance of oxygen, carbon dioxide, photosynthesis and respiration form an important part of this paper. Atmospheric processes to be examined include the oxygen budget; carbon dioxide and the greenhouse effect; acid rain and the sulphur cycle; photochemistry of exotic gases and the ozone shield; aerosols and the salt budget.

Hydrological processes include the water isotopes; soil processes and weathering; biological processes; geothermal and volcanic discharges; limnology; evaporation and salinification. A portion of the paper will be devoted to environmental and legal aspects of water rights. Marine chemistry will examine the exchange of gases, the circulation of the oceans, the fate of nutrients, the precipitation of carbonates, opal and other minerals from the sea, and the reactions that occur turning sediments into rocks.

Students will greatly benefit by taking this second semester paper in combination with the first semester paper, CHEM204 Analytical Chemistry and Instrumental Techniques. Students undertake three days of field-work and six 3–hour laboratory sessions.

Lecturer(s):	*Associate Professor Chris Hendy, Professor Alistair Wilkins and Professor Bill Henderson*
Prerequisite(s):	*At least 30 points in Chemistry or Earth Sciences (CHEM204 is recommended)*
Required book(s):	*Broecker **How to Build a Habitable Planet** (Eldigion Press), Andrews et al **An Introduction to Environmental Chemistry** (Blackwell Science)*
Assessment:	*Internal assessment/examination ratio: 1 : 0*

300 Level Papers

CHEM301-12A (HAM) – Advanced Organic Chemistry
20 Points
This paper looks at mass spectrometry and advanced NMR spectroscopy. It explores biosynthesis of natural products and advanced carbohydrate chemistry, as well as stereoelectronic effects, and enolates and enamines in synthesis and biosynthesis.

Lecturer(s):	*Associate Professor Alistair Wilkins, Dr Michèle Prinsep and Associate Professor Merilyn Manley-Harris*
Prerequisite(s):	*CHEM201*
Required book(s):	*McMurry **Organic Chemistry** 6th or 7th ed (Brooks/Cole); **Molecular Model Set** (available from the Chemistry Department)*
Assessment:	*Internal assessment/examination ratio: 1 : 1*

CHEM302-12B (HAM) – Advanced Physical Chemistry
20 Points
This paper covers topics selected from thermodynamics of real systems, surface chemistry, nanotechnology, reaction kinetics and mechanisms, metal corrosion, dynamic electrochemistry, and atomic and molecular structure as revealed by quantum chemistry.

Lecturer(s):	*Associate Professor Alan Langdon, Dr Joseph Lane and Dr Michael Mucalo*
Prerequisite(s):	*CHEM202*
Required book(s):	*Engel and Reid **Physical Chemistry** 1st ed (Pearson)*
Assessment:	*Internal assessment/examination ratio: 1 : 1*

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CHEM303-12A (HAM) – Advanced Inorganic Chemistry
20 Points
Topics dealt with in this paper include the chemistry of the heavier transition elements, and of the lanthanides and actinides. The important topics of bioinorganic chemistry and organometallic chemistry are also presented in some detail. Other aspects of inorganic chemistry that are explored include metal-hydride chemistry, electron-deficient compounds, and complex oxides and oxyanions. For the practical component of the paper, students spend 36 hours in the laboratory working on individual projects from inorganic chemistry. These usually combine quite demanding preparative chemistry with a research component.

Lecturer(s): *Professor Brian Nicholson, Professor Bill Henderson and Dr Graham Saunders*
Prerequisite(s): *CHEM203*
Required book(s): *Henderson et al **Introduction to Modern Inorganic Chemistry** 6th ed (Nelson Thornes) For intending MSc candidates: Either Cotton et al **Advanced Inorganic Chemistry** 6th ed (Wiley-Interscience); or Earnshaw et al **Chemistry of the Elements** (Pergamon)*
Assessment: *Internal assessment/examination ratio: 1 : 1*

CHEM304-12A/B/C/S/Y (HAM) – Special Topics in Chemistry
20 Points
Each student is assigned an independent or small team research project, which can be laboratory and/or literature-survey based. Students are expected to complete at least 100 hours of work on their project. Some informal seminars covering project/design and report writing are held, and students present their work to other class members at seminars.

Assessment is based mainly on the detailed reports that are submitted at the end of the paper. This paper provides a useful introduction to research for students who intend to progress to more serious research as part of a MSc programme, and is also a useful way for a student to gain familiarity with an instrumental technique (or techniques) in appropriate cases.

Co-ordinator(s): *Dr Michèle Prinsep*
Assessment: *Internal assessment/examination ratio: 1 : 0*

CHEM305-12B (HAM) – Environmental, Forensic, Toxicological and Medicinal Chemistry
20 Points
A paper with a selection of topics from heavy metals and organic compounds in the environment; arson, explosives and fingerprint investigations in forensic casework; toxicological effects in humans, drugs (particularly anti-cancer drugs) and other topics. An organic chemistry/biochemistry background is an advantage for this section of the paper.

The combination of CHEM305 and CHEM306 (built on the foundation of CHEM204) is highly recommended for students wishing to specialise in analytical chemistry.

Lecturer(s): *Dr Graham Saunders, Dr Joseph lane, Associate Professor Alan Langdon and Dr Michèle Prinsep*
Prerequisite(s): *CHEM201, CHEM209, or both CHEM102 and BIOL251*
Assessment: *Internal assessment/examination ratio: 2 : 3*

CHEM306-12B (HAM) – Advanced Analytical Chemistry
20 Points
Chemical analysis is an essential part of scientific research across the range of disciplines, and these days is usually carried out using specialised part-mechanical and part-electronic devices referred to as instruments. A sound understanding of analytical chemistry and the various instrumental methods of analysis is not only extremely useful to graduate research in biology, earth sciences and/or chemistry, but is also the skill most sought-after by New Zealand employers of chemistry graduates. In this paper, the aim is to further develop such an understanding.

Topics covered are as follows:

» Sampling, sample preparation, trace analysis, data interpretation
» Use of High Pressure Liquid Chromatography (HPLC)
» Radiochemical methods of analysis
» Interfacing computers and instruments
» Ion Selective Electrodes (ISEs)
» Inductively-Coupled Plasma Optical Emission Spectroscopy (ICP-OES)
» Chromatography with emphasis on Gas Chromatography-Mass Spectrometry (GC-MS)
» Emphasis in the laboratory course is on gaining practical working experience of the concepts and instruments discussed in lectures.

Lecturer(s):	*Associate Professor Alan Langdon, Professor Alistair Wilkins, Dr Graham Saunders and Associate Professor Chris Hendy*
Prerequisite(s):	*CHEM204*
Required book(s):	*Kellner et al **Analytical Chemistry** (Wiley-VCH) (Same book as CHEM204)*
Assessment:	*Internal assessment/examination ratio: 3 : 2*

BSc(Tech) Work Placement Papers

For details refer to Work Placements.